UNITED STATES PATENT AND TRADEMARK OFFICE

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2123	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

	Application No.	Applicant(s)
	10/046,715	ANAMI ET AL.
Office Action Summary	Examiner	Art Unit	
	JASON PROCTOR	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.
- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
  Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _25 February 2010_.

2a)☐ This action is **FINAL**.   2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1,2 and 5-22_ is/are pending in the application.

    4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1,2 and 5-22_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

    Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

    a)☒ All b)☐ Some * c)☐ None of:

      1.☒ Certified copies of the priority documents have been received.

      2.☐ Certified copies of the priority documents have been received in Application No. _____.

      3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

    * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☒ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4)☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____

5)☐ Notice of Informal Patent Application

6)☐ Other: _____.

DETAILED ACTION

Claims 1-2 and 5-22 were rejected in the Office Action entered on 2 December 2009.

A request for continued examination under 37 CFR 1.114, including the fee set forth in

37 CFR 1.17(e), was filed in this application after final rejection. Since this application is

eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e)

has been timely paid, the finality of the previous Office action has been withdrawn pursuant to

37 CFR 1.114. Applicant's submission filed on 25 February 2010 has been entered.

The 25 February 2010 submission has amended claims 1, 2, 7, 9, 11-15, 17-20, and 22.

Claims 1-2 and 5-22 are pending in this application.

Claims 1-2 and 5-22 are rejected.

Response to Remarks - 35 USC § 102

1.   In response to the previous rejection of claims 1-2 and 5-21 under 35 U.S.C. § 103(a) as

being obvious over Sebastian in view of Shebini, and the previous rejection of claim 22 under 35

U.S.C. § 102(b) as being anticipated by Sebastian, Applicants argue primarily that:

> Sebastian and Sehbini do not disclose or suggest, e.g., "a control section configured to ... determine, using
> [a] corresponding surface group, errors in [a] combined shape model arising from [a] second reference
> surface; ... wherein the errors determined using the corresponding surface group include at least one of a
> change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a
> direction of a surface, and folding of a surface," as recited in independent claim 1. Independent claims 2, 7,
> 9, 11-15, 17-20, and 22 contain similar recitations.

> In contrast, and as noted in the Office Action at page 5, the system disclosed in Sebastian detects whether
> parameters of a part, e.g., a thickness of a boss, correspond with a manufacturer's recommendation.
> Sebastian does not disclose or suggest, e.g., "determin[ing], using [a] corresponding surface group, errors in
> [a] combined shape model arising from [a] second reference surface; ... wherein the errors determined
> using the corresponding surface group include at least one of a change of a number of configuring surfaces,
> a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a
> surface," as recited in independent claim 1, and similar recited in independent claims 2, 7, 9, 11-14, 17-20,
> and 22. Shebini does not remedy the deficiencies of Sebastian.

This argument has been fully considered and found persuasive. Therefore, in response to the newly claimed feature, the previous rejection is <u>withdrawn</u>. New grounds of rejection are entered below.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. § 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. § 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was

made in order for the examiner to consider the applicability of 35 U.S.C. § 103(c) and potential

35 U.S.C. § 102(e), (f) or (g) prior art under 35 U.S.C. § 103(a).

2.   Claim 22 is rejected under 35 U.S.C. § 103(a) as being unpatentable over US Patent No.

5,552,995 to Sebastian in view of "Repairing CAD Models" by Gill Barequet et al. ("Barequet").

Regarding claim 22, Sebastian teaches a design support system [(abstract); *"...the*

present invention is implemented in the 'C++' programming language and uses Pro-Engineer

from Parametric Technology Inc. as its solid modeling and front-end CAD system." (column 11,

lines 21-26); *"The present invention enables a designer to create feature templates and store*

them in a feature template library." (column 13, lines 44-46)], comprising:

a database (FIG. 2, reference 34) which divides a history of design work for creating a

shape model, comprising a first reference surface, for each part of the shape model and holds a

plurality of design work histories as unit work history data [*"The template scheme provides a*

uniform data handling mechanism that spans the domain of part, tooling, process and material.

The templates of the present invention allow the collection, under a single header, of various

types of information: fixed parameters (e.g., user supplied data), parameters derived by

relationship with other parameters from the same template (e.g., a boss' outer diameter

computed from the value of its own inner diameter), parameters derived by relationship with

parameters from other templates in the same domain (e.g., a boss' height computed from the

thickness of the wall to which it is attached), and parameters derived by relationship with

parameters from other templates in other domains (e.g., a boss' draft angle computed from the

tool orientation relative to the boss)." (column 11, lines 32-49)]; and

a control section configured to:

fetch at least two unit work history data selected from the plurality of unit work

history data held by the database [*"An example of a feature template is a "support::tapered*

wall" feature template, wherein the primitive object is a tapered wall and the function of the

tapered wall is support. Another example is a "support::rib" feature template that represents a

type of projection known as a rib, where the rib has a support function. A tapered wall and a rib

can be regarded as sub-parts that can be used to make a part." (column 12, lines 3-11)];

combine the at least two selected unit work history data and output design work

data for creating a combined shape model, comprising a second reference surface, which is

formed by joining part shape models corresponding to the respective unit work history data

(column 12, lines 3-11; column 11, line 55 – column 12, line 3); and

create a corresponding surface group in accordance with user input of a

correspondence to determine, using the corresponding surface group, errors in the combined

shape model arising from the second reference surface [See column 22, *et seq.*, in particular:

"The designer starts by instantiating the nominal wall feature and uses the add-on operation to

provide "Fasten" functionality. In this example, the system searches for a function template

using "Fasten" as the search criteria and provides the user with the boss feature. The user

specifies the parameters for the boss such as dimension and positioning information. Based on

the selection, the reasoning attributes of the feature template are evaluated and the system

examines the appropriate constraints. The constraints retrieve necessary additionally

information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach that the errors determined using the corresponding surface group include at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian with Barequet to arrive at the

invention specified in claim 22.

3.   Claims 1-2 and 5-21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over US

Patent No. 5,552,995 to Sebastian in view of US Patent No. 4,858,146 to Shebini, further in view

of "Repairing CAD Models" by Gill Barequet et al. ("Barequet").

Regarding claim 1, Sebastian teaches:

A design support system [(abstract); *"...the present invention is implemented in the*

'C++' programming language and uses Pro-Engineer from Parametric Technology Inc. as its

solid modeling and front-end CAD system." (column 11, lines 21-26); *"The present invention*

enables a designer to create feature templates and store them in a feature template library."

(column 13, lines 44-46)], comprising:

database (FIG. 2, reference 34) which divides a history of design work for creating a

shape model, comprising a first reference surface, for each part of the shape model and holds a

plurality of design work histories as unit work history data [*"The template scheme provides a*

uniform data handling mechanism that spans the domain of part, tooling, process and material.

The templates of the present invention allow the collection, under a single header, of various

types of information: fixed parameters (e.g., user supplied data), parameters derived by

relationship with other parameters from the same template (e.g., a boss' outer diameter

computed from the value of its own inner diameter), parameters derived by relationship with

parameters from other templates in the same domain (e.g., a boss' height computed from the thickness of the wall to which it is attached), and parameters derived by relationship with parameters from other templates in other domains (e.g., a boss' draft angle computed from the tool orientation relative to the boss)." (column 11, lines 32-49)]; and

a control section configured to fetch at least two unit work history data selected from the plurality of unit work history data held by the database [*"An example of a feature template is a "support::tapered wall" feature template, wherein the primitive object is a tapered wall and the function of the tapered wall is support. Another example is a "support::rib" feature template that represents a type of projection known as a rib, where the rib has a support function. A tapered wall and a rib can be regarded as sub-parts that can be used to make a part."* (column 12, lines 3-11)]; and

combine at least two selected unit work history data and output design work data for creating a combined shape model, comprising a second reference surface, which is formed by joining part shape models corresponding to the respective unit work history data (column 12, lines 3-11; column 11, line 55 – column 12, line 3);

create a corresponding surface group in accordance with user input of a correspondence (column 12, lines 3-11; column 11, line 55 – column 12, line 3); and

determine, using the corresponding surface group, errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies*

the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations ... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a database accumulating technical conditions, which are to be met by a part shape model to be created according to each unit work history data, in association with each unit work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional*

requirements and methods of installation." (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4]; and

computing at least one technical characteristic value of the combined shape model which is created from the output design work data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with the technical conditions related to unit work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the combined shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or

quantity of border lines, reversal of a direction of a surface, and a folding of a surface ["*We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc.*" (Barequet, abstract); "*If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component...*" (Barequet, page 366, "4.2 Orientation Checking"); "*The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such.*" (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model ["*File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling*

geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-

orientations." (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at

the invention specified in claim 1.

Regarding claim 2, Sebastian teaches:

A design support system which outputs work data for creating a shape model, comprising

a first reference surface, of a design target in order to create the shape model of the design target

conforming to a standard shape [(abstract); (column 11, lines 32-49)], comprising:

A database which holds a plurality of unit work history data which are obtained by

dividing a history of a design work performed with reference to a first standard shape for each

design work history corresponding to a shape model of a predetermined portion (column 11,

lines 32-49);

A control section configured to receive designation of data about a second standard shape

(FIG. 2, reference 35);

Fetch multiple unit work history data selected from the multiple unit work history data

held by the database (column 12, lines 3-11); and

combine each of the fetched unit work history data, reproduce design work with reference to the designated second standard shape for the design works performed with reference to the first standard shape among the design works contained in the unit work history data, and output work data corresponding to a combined shape model, comprising a second reference surface conforming to the second standard shape [(column 11, lines 32-49); (column 11, line 55 - column 12, line 11)]; and

create a corresponding surface group in accordance with user input of a correspondence to determine if there are errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of*

appropriate thickness values for the selected material that satisfies both the mold fill and the

strength criteria." (column 22, line 18, *et seq.*)].

       Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

       Shebini teaches the database accumulating technical conditions, which are to be met by a part shape model to be created according to each unit work history data, in association with each unit work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the combined shape model which is created from the output work data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

compare the computed technical characteristic value with technical conditions related to unit work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the combined shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be*

used to determine stresses for structural parts where no mathematically closed form solution

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

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including at least one of a change of a number of configuring surfaces, a change in direction or

quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We*

describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid

models due to imprecise arithmetic, model transformations, designer's fault, programming bugs,

etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make*

the following modifications to our algorithm: Orient all the facets of each connected component

consistently with respect to other facets in the component..." (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while*

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a

consistency check between two facets whose respective orientations are already fixed. If the two

orientation do not match, the component is non-orientable and the system reports the error as

such." (Barequet, page 365, "2 Computing the Connected Components")].

        Sebastian in view of Shebini and Barequet are analogous art because both are directed to

CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 2.

Regarding claim 5, Sebastian teaches:

The design support system according to claim 2, wherein the control section is further configured to receive designation of data about a third standard shape (FIG. 2, reference 35); wherein:

The work data is converted by reproducing a design work with reference to the designated third standard shape for work included in the work contained in the output work data and performed with reference to the second standard shape, and converted work data corresponding to a shape model conforming to the third standard shape is output [(column 11, lines 32-49); (column 12, lines 3-11)].

Regarding claim 6, Sebastian teaches:

The design support system according to claim 1, wherein the control section is further configured to analyze the history of design work and extract input work carried out by a person in charge of work when unit historical data is created [*"CreateT... creates a new template..."* (column 21, lines 50-55, etc.)]; and the design support system further including:

A display section which shows the extracted input work to the person in charge of work to request input of design support information [*"In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature."* (column 22, lines 21-28); *"At any time the user has the ability to modify the feature attribute values and the system processes the effect of these changes..."* (column 22, lines 57-65)]; and

A database which records the design support information in a history of the design work and divides the history of the design work into unit historical data when the design support information is input so to show when the design support information is reused (column 22, lines 41-65).

Regarding claim 7, Sebastian teaches:

A design support system which holds a series of design work histories to reuse as work history data and creates a shape based on the work history data [(abstract); (column 11, lines 32-49); (column 12, lines 3-11)], comprising:

A control section which analyzes the work history data, comprising a first reference surface, to extract input work, comprising a second reference surface, carried out by a person in charge of work [(column 11, lines 32-49), (column 21, lines 50-55, etc.)];

creates a corresponding surface group in accordance with user input of a correspondence and determines, using the corresponding surface group, errors in the extracted input work arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning*

messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

A display section which shows the extracted input work to the person in charge of work to request input of design support information (column 22, lines 21-65); and

A database which records the design support information in the work history data when the design support information is input so to show when the design support information is reused (column 22, lines 41-65).

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors detected using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the shape created based on the work history data, in association with the work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-*

column analysis of the piling can be considered finished, it is necessary to determine compatible

conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained

using an interaction analysis procedure which yields the combined response of the linear

structure and its non-linear soil-pile foundation for nay imposed static load condition." (Shebini,

column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical

conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based

on the work history data [*"The equilibrium conditions determined from the interaction analysis*

are now imposed on the structural Model in combination with appropriate design loads, and a

static analysis is performed. The internal member forces determined in this analysis are

employed to check the stress levels in the members." (Shebini, column 4, line 65 - column 5, line

2)]; and

comparing the computed technical characteristic value with technical conditions related

to work history data which is the origin of the work data [*"The stresses are compared to*

allowable stresses, as set forth in the design basis, and members resized accordingly." (Shebini,

column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises

analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 -

column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated

by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by*

using the Finite Element Method (FEM), stress analysts do not have to modify the problem to

conform to available solutions. No matter how complex the shape or system of loads may be,

the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or

elements as are shown in FIG. 8. Since these elements can be put together in virtually any

fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be

used to determine stresses for structural parts where no mathematically closed form solution

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly that the errors determined using the

corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors

including at least one of a change of a number of configuring surfaces, a change in direction or

quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We*

describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid

models due to imprecise arithmetic, model transformations, designer's fault, programming bugs,

etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make*

the following modifications to our algorithm: Orient all the facets of each connected component

consistently with respect to other facets in the component..." (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while*

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a

consistency check between two facets whose respective orientations are already fixed. If the two

orientation do not match, the component is non-orientable and the system reports the error as

such." (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to

CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as

expressly motivated by Barequet to identify and correct problems in the CAD model [*"File*

formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping

industry) allow users to represent models as such soups of polygons... The collection of polygons

is assumed to represent a complete model. Unfortunately this is often not the case. Typical

problems include cracks (in the surface), degeneracies, duplication (of patches of the surface),

holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling

geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-

orientations." (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at

the invention specified in claim 7.

Regarding claim 8, Sebastian teaches:

The design support system according to claim 7, wherein the database is further

configured to generate unit work history data by dividing the work history data into

predetermined work units for a design target (column 21, lines 50-55, etc.).

Regarding claim 9, Sebastian teaches:

A design support system (abstract), comprising:

A database which accumulates unit work history data which is formed by dividing a

history of past design work, comprising a first reference surface, into work units determined for a

design target and contains design support information related to input work among the design

work [(column 11, lines 32-49); (column 12, lines 3-11)];

A control section configured to selectively show the unit work history on a display

section upon receiving designation of the design target [(column 22, lines 21-65) alternatively

(column 16, lines 19-47)];

Create a shape comprising a second reference surface by sequentially reproducing the

selected unit work history [(column 11, lines 32-49); (column 12, lines 3-11)];

Provide design support information related to input work when the input work is demanded while the unit work history is being reproduced [(column 22, lines 21-65) alternatively (column 16, lines 19-47)];

create a corresponding surface group in accordance with user input of a correspondence, and determine, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria."* (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created based on each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are*

employed to check the stress levels in the members." (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping*

industry) allow users to represent models as such soups of polygons... The collection of polygons

is assumed to represent a complete model. Unfortunately this is often not the case. Typical

problems include cracks (in the surface), degeneracies, duplication (of patches of the surface),

holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling

geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-

orientations." (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at

the invention specified in claim 9.

Regarding claim 10, Sebastian teaches:

The design support system according to claim 9, wherein the control section is further

configured to judge whether the work history to be reproduced agrees with predetermined

guidance display conditions while the unit work history is being reproduced (column 22, lines

21-65); and wherein

The display section is further configured to implement a guidance display determined in

connection with the guide display conditions if the work history agrees with the guidance display

conditions (column 22, lines 21-65).

Regarding claim 11, Sebastian teaches:

A database which accumulates unit work history data which is formed by dividing a history of past design work into work units, comprising a first reference surface, determined for a design target and contains design support information related to an input work among the design work [(abstract); (column 11, lines 32-49); (column 12, lines 3-11)];

A first display device which shows a shape, comprising a second reference surface, of the design target obtained by sequentially reproducing a history of the design work with reference to the unit work history data [*"The representative embodiment supports, amongst others, the following interfaces: to CAD systems – IGES, Pro-Engineer and IDEAS; for FEM structural analysis – PATRAN/NASTRAN and IDEAS; for FEM molding filling, cooling and shrinkage analysis – C-FLOW, IDEAS, Moldflow and TMC; and for tool design – IDEAS, Pro-Engineer and DME Moldbase Catalog."* (column 18, lines 35-41)];

A second display device which shows design support information contained in the unit work history data by reproducing a history of the design work prior to the reproduction at the first display device [(column 18, lines 35-41); (column 11, lines 21-26)]; and

a control section which creates a corresponding surface group in accordance with user input of a correspondence, and determines, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user*

specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created based on each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional*

requirements and methods of installation." (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.*

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at

the invention specified in claim 11.

Regarding claim 12, Sebastian teaches:

A design support method using a computer, wherein:

A series of design work histories is held in multiple quantities as work history data,

comprising a first reference surface in a database in order to create a part shape model

[(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)];

At least two selected history data are fetched from the held multiple work history data

according to an instruction input to a processor (column 22, lines 21-65); and

Design work data for creating a one-piece shape model comprising a second reference

surface by combining the at least two fetched work history data and connecting part shape

models corresponding to the respective work history data is output (column 11, line 32 - column

12, line 11); and

a corresponding surface group is created by a control section in accordance with user

input of a correspondence, errors in the one-piece shape model arising from the second reference

surface are determined, using the corresponding surface group, by the control section [See

column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature*

and uses the add-on operation to provide "Fasten" functionality. In this example, the system

searches for a function template using "Fasten" as the search criteria and provides the user with

the boss feature. The user specifies the parameters for the boss such as dimension and

positioning information. Based on the selection, the reasoning attributes of the feature template

are evaluated and the system examines the appropriate constraints. The constraints retrieve

necessary additionally information from other feature templates, look-up tables and the material

database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that

the thickness of the boss is adequate to support the applied load. However, while considering

the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved

from the manufacturer's external database) for the selected material. Depending on the

constraint evaluation results, the user is notified through one of the following mechanisms:

warning messages, error messages and design change recommendations… In the boss example,

the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of

appropriate thickness values for the selected material that satisfies both the mold fill and the

strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as

claimed, or that the errors determined using the corresponding surface group include the types

recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by

the part shape model to be created according to each work history data, in association with each

work history data [*"Turning to very particular structures, namely off-shore platforms, we see*

that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation." (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the one-piece shape model which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.*

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini
to identify and correct the same types of errors in Sebastian's CAD models. The combination
would produce a system as described by Sebastian in view of Shebini but enhanced with the
error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of
Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at
the invention specified in claim 12.

Regarding claim 13, Sebastian teaches:

A design support method which uses a computer to create a shape model of a design
target conforming to a desired standard shape according to input to its processor and outputs
work data for creating the shape model of the design target [(abstract); (column 11, lines 32-49);
(column 12, lines 3-11); (column 13, lines 44-46)], comprising the steps of:

Holding a plurality of histories of design work performed in the past with reference to the
respective standard shapes, comprising a first reference surface, in a database as work history
data (column 13, lines 44-46);

Accepting designation of data about a second standard shape, which is a desired standard
shape, according to an instruction input to the processor (column 22, lines 21-65);

Fetching the selected multiple work history data from the multiple work history data held
in the database (column 22, lines 21-65); and

Combining respective pieces of the fetched work history data, reproducing design work
with reference to the designated second standard shape for the design work performed in the past
with reference to the respective standard shapes among the design work contained in the work

history data, and outputting work data corresponding to a combined shape model conforming to the second standard shape (column 12, lines 3-11); and

creating a corresponding surface group and determining, using the corresponding surface group, errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria."* (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the one-piece shape model which is created based on the fetched work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces*

determined in this analysis are employed to check the stress levels in the members." (Shebini,

column 4, line 65 - column 5, line 2)]; and

      comparing the computed technical characteristic value with technical conditions related

to work history data which is the origin of the design work data [*"The stresses are compared to*

allowable stresses, as set forth in the design basis, and members resized accordingly." (Shebini,

column 5, lines 2-5)];

      wherein the computation of the at least one technical characteristic value comprises

analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini,

column 4, line 65 - column 5, line 5)].

      Sebastian and Shebini are analogous art because both are drawn to structural modeling.

      It would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated

by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by*

using the Finite Element Method (FEM), stress analysts do not have to modify the problem to

conform to available solutions. No matter how complex the shape or system of loads may be,

the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or

elements as are shown in FIG. 8. Since these elements can be put together in virtually any

fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be

used to determine stresses for structural parts where no mathematically closed form solution

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping*

industry) allow users to represent models as such soups of polygons... The collection of polygons

is assumed to represent a complete model. Unfortunately this is often not the case. Typical

problems include cracks (in the surface), degeneracies, duplication (of patches of the surface),

holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling

geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-

orientations." (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at

the invention specified in claim 13.

Regarding claim 14, Sebastian teaches:

A design support method which holds a series of design work histories as work history

data in order for reuse and generates a shape by a computer according to the work history data

according to an instruction input to a processor [(abstract); (column 11, lines 32-49); (column 12,

lines 3-11); (column 13, lines 44-46)], comprising the steps of:

Analyzing the work history data upon input to the processor to extract the input work

performed by a person in charge of work (column 22, lines 21-65);

Showing the extracted input work to the person in charge of work to request input of

design support information;

when the design support information is input, recording the design support information in the work history data [(column 11, lines 32-49); (column 22, lines 21-65)]; and

creating a corresponding surface group and determining, using the corresponding surface group, errors in the extracted input work arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria."* (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the fetched work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are*

employed to check the stress levels in the members." (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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industry) allow users to represent models as such soups of polygons... The collection of polygons

is assumed to represent a complete model. Unfortunately this is often not the case. Typical

problems include cracks (in the surface), degeneracies, duplication (of patches of the surface),

holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling

geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-

orientations." (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at

the invention specified in claim 14.

Regarding claim 15, Sebastian teaches:

A design support method, comprising the steps of:

Accumulating, using a computer, unit work history data which is formed by dividing a

history of past design work into work units, comprising a first reference surface, determined for a

design target and contains design support information related to input work among the design

work;

Showing the unit work history selectively upon receiving designation of the design target

by the computer;

Creating a shape, comprising a second reference surface, by sequentially reproducing the selected unit work history;

Providing the design support information related to input work when the input work is demanded while the unit work history is being reproduced [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46); (column 22, lines 21-65). This claim presents a combination of limitations recited by previous claims. These citations of the prior art are explained in more detail in the context of the previous claims.]; and

creating a corresponding surface group; and determining, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the*

system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate

thickness values for the selected material that satisfies both the mold fill and the strength

criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as

claimed, or that the errors determined using the corresponding surface group include the types

recited by the claim.

Shebini teaches the accumulating, using the computer, technical conditions, which are to

be met by a part shape model to be created according to each work history data, in association

with each work history data [*"Turning to very particular structures, namely off-shore platforms,*

we see that they must be structurally adequate for operational and environmental loading,

practical to construct, and be cost effective. The selection of a configuration is based on

functional requirements and methods of installation." (Shebini, column 3, lines 60-65); *"Once*

environmental loads are determined, they are combined with operational loads, and an estimate

is made of the resulting pile mudline moments and axial forces." (Shebini, column 4, lines 33-

39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the*

superstructure and jacket, or the beam-column analysis of the piling can be considered finished,

it is necessary to determine compatible conditions at the pilehead-structure interface. These

equilibrium conditions are usually obtained using an interaction analysis procedure which yields

the combined response of the linear structure and its non-linear soil-pile foundation for nay

imposed static load condition." (Shebini, column 4, lines 55-65); *et cetera.* Shebini provides

numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to unit work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution*

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

      Sebastian in view of Shebini does not expressly teach that the errors determined using the

corresponding surface group include the types recited by the claim.

      Barequet teaches determining errors using a corresponding surface group, the errors

including at least one of a change of a number of configuring surfaces, a change in direction or

quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We

describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid

models due to imprecise arithmetic, model transformations, designer's fault, programming bugs,

etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make

the following modifications to our algorithm: Orient all the facets of each connected component

consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a

consistency check between two facets whose respective orientations are already fixed. If the two

orientation do not match, the component is non-orientable and the system reports the error as

such."* (Barequet, page 365, "2 Computing the Connected Components")].

      Sebastian in view of Shebini and Barequet are analogous art because both are directed to

CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 15.

Regarding claim 16, Sebastian teaches wherein it is judged whether the work history to be reproduced conforms to predetermined guidance display conditions while the unit work history data is being reproduced by the computer and, if it conforms to the guidance display

conditions, a guidance display determined in connection with the guide display conditions is performed (column 22, lines 21-65).

Regarding claim 17, Sebastian teaches a recording medium storing a design support program and being computer-readable, the design support program comprising:

A module holding a series of design work histories as a plurality of work history data, comprising a first reference surface, for creation of a part shape model, comprising a second reference surface [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)];

A module fetching at least two selected work history data from the held multiple work history data (column 22, lines 21-65); and

A module for outputting design work data for creating a one-piece shape model by combining the at least two fetched work history data and connecting part shape models corresponding to the respective work history data (column 12, lines 3-11); and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the part shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system*

examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-*

39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the one-piece shape model which is created from the design work data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to unit work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

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by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by*

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conform to available solutions. No matter how complex the shape or system of loads may be,

the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or

elements as are shown in FIG. 8. Since these elements can be put together in virtually any

fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be

used to determine stresses for structural parts where no mathematically closed form solution

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the

corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors

including at least one of a change of a number of configuring surfaces, a change in direction or

quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We*

describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid

models due to imprecise arithmetic, model transformations, designer's fault, programming bugs,

etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make*

the following modifications to our algorithm: Orient all the facets of each connected component

consistently with respect to other facets in the component..." (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a

consistency check between two facets whose respective orientations are already fixed. If the two

orientation do not match, the component is non-orientable and the system reports the error as

such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to

CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as

expressly motivated by Barequet to identify and correct problems in the CAD model [*"File

formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping

industry) allow users to represent models as such soups of polygons... The collection of polygons

is assumed to represent a complete model. Unfortunately this is often not the case. Typical

problems include cracks (in the surface), degeneracies, duplication (of patches of the surface),

holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling

geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-

orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by

using Barequet's algorithms in the system and method described by Sebastian in view of Shebini

to identify and correct the same types of errors in Sebastian's CAD models. The combination

would produce a system as described by Sebastian in view of Shebini but enhanced with the

error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian, Shebini, and Barcquet to arrive at

the invention specified in claim 17.

Regarding claim 18, Sebastian teaches:

A recording medium storing a design support program and being computer-readable, the

design support program comprising:

A module outputting work data for creating a shape model of a design target in order to

create the shape model of the design target conforming to a desired standard shape [(column 11,

lines 32-49); (column 12, lines 3-11)];

A module holding a history of design work performed with reference to a first standard

shape, comprising a first reference surface, as a plurality of work history data [(column 11, lines

32-49); (column 12, lines 3-11)];

A module receiving designation of data about a second standard shape, comprising a

second reference surface, which is a desired standard shape [(column 11, lines 32-49); (column

12, lines 3-11)];

A module fetching the selected multiple work history data from the held multiple work

history data (column 22, lines 21-65); and

A module combining each of the fetched work history data, reproducing design work

with reference to the designated second standard shape for the design works performed with

reference to the first standard shape among the design works contained in the work history data,

and outputting work data corresponding to a one-piece shape model conforming to the second

standard shape [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46); (column 22, lines 21-65). This claim presents a combination of limitations recited by previous claims. These citations of the prior art are explained in more detail in the context of the previous claims.]; and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the second standard shape caused by the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate*

thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the one-piece shape model which is created from the design work [*"The equilibrium conditions determined from the*

interaction analysis are now imposed on the structural Model in combination with appropriate

design loads, and a static analysis is performed. The internal member forces determined in this

analysis are employed to check the stress levels in the members." (Shebini, column 4, line 65 -

column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical

conditions related to unit work history data which is the origin of the design work data [*"The*

stresses are compared to allowable stresses, as set forth in the design basis, and members

resized accordingly." (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises

analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini,

column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of

Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated

by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by*

using the Finite Element Method (FEM), stress analysts do not have to modify the problem to

conform to available solutions. No matter how complex the shape or system of loads may be,

the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or

elements as are shown in FIG. 8. Since these elements can be put together in virtually any

fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be

used to determine stresses for structural parts where no mathematically closed form solution

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the

corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors

including at least one of a change of a number of configuring surfaces, a change in direction or

quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We*

describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP.

Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid

models due to imprecise arithmetic, model transformations, designer's fault, programming bugs,

etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make*

the following modifications to our algorithm: Orient all the facets of each connected component

consistently with respect to other facets in the component..." (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while*

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a

consistency check between two facets whose respective orientations are already fixed. If the two

orientation do not match, the component is non-orientable and the system reports the error as

such." (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to

CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 18.

Regarding claim 19, Sebastian teaches:

A recording medium storing a design support program and being computer-readable, the design support program comprising:

A module holding a series of design work histories, comprising a first reference surface, to reuse as a work history data (column 13, lines 44-46);

A module analyzing the work history data to extract input work performed by a person in charge of work (column 22, lines 21-65);

A module showing the extracted input work, comprising a second reference surface, to the person in charge of work to receive input of design support information (column 22, lines 21-65); and

A module recording the design support information in the work history data when the design support information is input (column 22, lines 21-65); and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the extracted input work arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the*

manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations… In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields*

the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the extracted input work which is created from the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the extracted input work [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or*

elements as are shown in FIG. 8. Since these elements can be put together in virtually any

fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be

used to determine stresses for structural parts where no mathematically closed form solution

exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's

structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the

corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors

including at least one of a change of a number of configuring surfaces, a change in direction or

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Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid

models due to imprecise arithmetic, model transformations, designer's fault, programming bugs,

etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make*

the following modifications to our algorithm: Orient all the facets of each connected component

consistently with respect to other facets in the component..." (Barequet, page 366, "4.2

Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while*

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a

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such." (Barequet, page 365, "2 Computing the Connected Components")].

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Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 19.

Regarding claim 20, Sebastian teaches:

A recording medium storing a design support program and being computer-readable, the design support program comprising:

A module accumulating unit work history data which is formed by dividing a history of past design work into work units, comprising a first reference surface, determined for a design target and contains design support information related to input work among the design work [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)];

A module selectively showing the unit work history upon receiving designation of the design target (column 22, lines 21-65);

A module creating a shape, comprising a second reference surface, by sequentially reproducing the selected unit work history [(column 11, lines 32-49); (column 12, lines 3-11)]; and

A module providing design support information related to an input work when the input work is demanded while the unit work history is being reproduced (column 16, lines 19-47); and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally*

information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model to be created according to each unit work history data, in association with each unit work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-

39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the shape which is created from the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated

by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while*

processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such." (Barequet, page 365, "2 Computing the Connected Components")].

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 20.

Regarding claim 21, Sebastian teaches:

The recording medium being computer-readable according to claim 20, wherein:

The design support program stored in the recording medium further includes a module judging whether the work history to be reproduced agrees with predetermined guidance display conditions while the unit work history is being reproduced and, if the work history agrees with the guidance display conditions, implements a guidance display determined in connection with the conditions [(column 16, lines 19-47); (column 22, lines 21-65)].

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason Proctor whose telephone number is (571) 272-3713. The examiner can normally be reached on 8:30 am-4:30 pm M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Rodriguez can be reached at (571) 272-3753. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Any inquiry of a general nature or relating to the status of this application should be directed to the TC 2100 Group receptionist: 571-272-2100. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR)

system. Status information for published applications may be obtained from either Private PAIR

or Public PAIR. Status information for unpublished applications is available through Private

PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov.

Should you have questions on access to the Private PAIR system, contact the Electronic Business

Center (EBC) at 866-217-9197 (toll-free).

/Jason Proctor/
Primary Examiner, Art Unit 2123

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